CONTENTS

TABLES

1. SCOPE

1.1 Content. This document establishes the general manufacturing and testing requirements for electromagnetic relays with contact ratings of 5 amperes (resistive) and upward. (Auxiliary contacts may be rated at lower currents.) MIL-R-6016 is used as the baseline; this document lists exceptions to it and adds requirements to make it suitable for the acquisition of relays to meet the quality and reliability requirements of JPL Mission Class A and B missions. An optional lot qualification flow is provided for procurement of relays from manufacturers who are not qualified (as defined by MIL-R-6106) at an acceptable level. (Any requirement for lot QCI will be specified in the detail specification or the procurement document.) Detail requirements, specific characteristics of relays, and other provisions which are sensitive to the particular use intended shall be specified in the applicable detail specification. This document is not intended for qualification of parts (inclusion in the qualified products list, QPL) as defined by MIL-R-6106 or for listing on an approved parts list. Qualification status will, however, determine whether lot QCI will be required.

2. APPLICABLE DOCUMENTS

2.1 Government specifications and standards. Delete and substitute as follows:

2.1.1 Government specification on which this exceptions document is based. The requirements for Type I ER, failure rate level P (0.1%/10,000 operations), of the following document, of the issue indicated, form a part of this specification unless exceptions are noted herein, in the detail specification, or in the procurement document. The specification of failure rate level P requirements does not imply that the manufacturer or product be MIL qualified to that failure rate level: it is intended only as a means of defining test requirements. The manufacturer may contact the JPL contract negotiator to obtain copies of this document."

SPECIFICATION	
Military	
MIL-R-6106	Relays, Electromagnetic, Established Reliability (ER) Types, General Specification for, including Amendment 3

2.1.2 Other government specifications. The following specification forms a part of this specification to the extent specified herein.

SPECIFICATION	
Military	
MIL-R-39016	Relays, Electromagnetic, Established Reliability, General Specification for, including Amendment 1

Add paragraph 2.3 as follows:

2.3 General exceptions and clarifications. References to the U.S. Government and its agencies shall be taken to refer to JPL. The detail specification shall be the JPL detail specification. The requirements herein apply specifically to relays being processed for JPL: they do not apply to parts for other customers.

3. REQUIREMENTS

Requirements of Paragraph 3 apply with the exception of the following:

3.1 Specification sheets, Military Standard (MS) sheets and Air Force-Navy Aeronautical (AN) standards. Delete and substitute as follows:

3.1 Order of precedence. In the event of a conflict between the requirements of this document and other requirements, the precedence in which requirements shall govern, in descending order, is as follows:

a. Procurement document (contract or purchase order)
b. Applicable device specification (associated detail specification or drawing)
c. This specification
d. Specification and Standard referenced in 2.1.

3.3 Materials. Add the following: "The manufacturer shall advise the JPL contract technical manager and contract negotiator of any changes in materials that would affect form, fit or function of the relay ."

3.4 Design and construction.

3.4.5 Enclosures.

3.4.5.2 Hermetically sealed enclosures. Delete the references to solder sealing and substitute as follows: "Sealing shall be by laser welding. No adjunct sealers shall be used."

3.39 Operational reliability (applicable to type I ER relays and relays screened to Group A Type I ER testing (see 3.1). Modify as follows: If contact resistance (in lieu of voltage drop) is monitored, it shall not exceed 100Ω regardless of how many contacts are series connected. In the event of failure of any contact set, the failure shall be recorded by relay serial number, contact set, and test name or number; testing shall continue through the remaining operations in the respective 1,000-cycle increment; the failed relay shall be rejected.

3.41 Particle impact noise detection (P.I.N.D., when specified, see 3.1). Delete and substitute as follows:

3.41 Particle impact noise detection (PIND). PIND is required. When relays are tested as specified in the JPL detail specification or 4.7.32, there shall be no evidence of free moving particulate contamination.

3.43 Identification of product. Substitute the following for items a. through i.:

a. part number in accordance with the JPL detail specification. The basic pattern shall be as follows:

33333-K333333XY

where:

33333	identifies the detail specification, excluding the letter prefix ("ST", e.g.)
K	identifies the JPL descriptor code for the device family (K is for relays)
333333	is the generic or manufacturer's catalog part number (or a portion thereof) and, if possible, the coil voltage.
X	indicates the type of terminal and mounting: L = solder lug, no mounting flange M = solder lug, mounting flange P = pin, no mounting flange Q = pin, mounting flange
Y	specifies whether the relay is latching or non-latching: L = latching N = non-latching

b Manufacturer's part number
c. Manufacturer's logo or name
d. Date code
e. Inspection lot number
f. Serial number
g. Circuit diagram

Add the following paragraphs:

3.45 JPL review of manufacturer's documentation. The manufacturer shall make available the lot traveler(s) and applicable procedures for each part type (covering assembly, in-process inspections, screening, and any lot sample QCI operations) for review and approval by technical direction from the JPL contract technical manager prior to use with their respective JPL lots. Any changes in approved documentation must be approved by technical direction from the JPL contract technical manager before they are implemented with JPL lots.

3.45.1 Manufacturer's drawings required for review. Drawings covering the following component parts shall be made availble for review by JPL personnel:

a. Armature
b. Side plates
c. Pole pieces
d. Magnets
e. Cores
f. Coils
g. Contacts
h. Weld joints (including alignment after welding):
   sideplate-to-pole pieces
   magnet assembly-to-header
   coil lead-cross-wire
   magnet welds
i. Core installation and swaging
j. Relay subassemblies and assembly

3.45.2 Manufacturer's written manufacturing procedures required for review: Written procedures covering the following operations shall be made available for review by JPL personnel:

a. Plating processes and finishes
b. Magnetization
c. Coil winding

3.46 Data required with shipments. Data shall be identified by part number, lot number, trace number, and serial number range. The following data shall be included with each shipment of screened parts:

a. A copy of the completed lot traveler(s) used for screening and (if applicable) lot sample QCI, showing disposition of each serial number in the lot
b. A copy of attributes data for group A and (if required) group B quality conformance inspections
c. Electrical test data for all specified tests, including control unit data and delta calculations
d. Data for any other special tests required by the detail specification or procurement document
e. Copies of reports on any failure analyses or engineering evaluations performed by the manufacturer
f. Copies of any waivers or Technical Direction Memoranda (TDMs) altering the specified requirements
g. Certificate of conformance to the requirements of this specification, signed by the manufacturer's authorized representative

If tests are labeled with test numbers, a cross-reference shall be provided to relate test numbers to descriptive test name and contact set number. It is preferred that printed electrical test data be formatted such that all measurements of a given parameter are displayed in a column, in serial number order. Electrical test data also shall be provided in a magnetic medium: either IBM DOS-compatible 5-1/4" or 3-1/2" diskette with data in ASCII format

or 9-track tape (800 or 1600 bpi) with data in ASCII or EBCDIC format. (If the requirement for magnetic data is waived, two copies of printed data shall be provided.)"

3.47 Serialization. Parts shall be serialized prior to the first electrical test in screening.

3.48 Control units. A control unit shall be measured and recorded immediately before and after each set of electrical measurements of the test specimens. (It is preferred that the same control units be used for all JPL lots of the same device type.) Each set of control unit measurements shall be checked for consistency with the last prior set of control unit measurements before proceeding with testing of the lot. In the event of significant discrepancy between two readings, corrective action (maintenance or re-calibration of the test equipment) and retest of control units shall be accomplished before proceeding with testing of the lot. Note that these control units shall be used for measurements during any required Group B sample tests as well as during Group A screening.

3.49 Problem notification. The contractor shall notify the JPL contract technical manager and the contract negotiator within two working days of the occurrence of any of the following during processing of a JPL lot.

a. Any catastrophic failure after initial electrical test
b. Any failure in group B
c. Any need for re-marking serial numbers

3.50 Failure analysis. JPL retains the option of performing any failure analysis: the manufacturer shall not do any analysis destructive of the part without prior consent of the JPL contract technical manager.

3.51 Status reporting. The contractor shall provide the JPL contract technical manager and the contract negotiator every two weeks with an oral or written status report stating the current status (point on the lot traveler and quantity of parts in the lot) and expected ship date of each lot in process, and noting any significant problems.

3.52 Destructive Physical Analysis (DPA) samples. If Group B QCI is required, the manufacturer shall make available to the JPL contract technical manager 3 samples from each JPL lot immediately upon completion of group A screening, for DPA. The manufacturer shall continue processing of the lot. There is no lot jeopardy associated with the results of JPL's DPA unless a defect is found which is unacceptable under the terms of the contract.

3.53 Disposition of Group A rejects. Relays which fail any of the Group A inspections shall be identified as to the test failed and retained with the lot data.

3.54 Pre-seal inspection. Prior to sealing the relay enclosure, a visual inspection and small particle inspection in accordance with ¶4.7.1.1 shall be performed.

4. QUALITY AND RELIABILITY ASSURANCE PROVISIONS

Requirements of paragraph 4 apply with the exception of the following:

4.1 Responsibility for inspection. Add the following: "JPL QA source inspection is required at 3 points: (1) in-process visual inspection of motor and armature/magnet assembly ("in-process"), (2) prior to cleaning and seal ("pre-seal"), and (3) prior to shipment ("pre-ship"). The contractor shall notify JPL QA at least 2 working days in advance of the scheduled inspection time. Adequate inspection stations shall be provided for the JPL QA representative."

4.1.1 Test equipment and inspection facilities. Add the following: "JPL may perform a survey to ascertain compliance with the requirements of this paragraph. Information regarding recent government audits, if any, shall be made available upon request."

4.5 Qualification inspection. Applies only to manufacturers of qualified relays.

4.6 Quality conformance inspection. Add the following: "All inspection data shall be retained by the manufacturer for a minimum of 5 years after performance of the inspection."

4.6.1 Inspection of product for delivery. Add the following: "If group B is required, the screened parts shall not be shipped until the inspection lot has passed the group B quality conformance inspection unless the JPL contract technical manager has given technical direction to ship ahead of QCI completion or unless prior shipment is required herein (e.g., catastrophic failures for analysis)."

4.6.1.1 Inspection lot.

Add the following subparagraph:

4.6.1.1.1 Serialization and traceability. Each relay shall be uniquely serialized prior to the initial electrical test in screening and shall be traceable to the inspection lot and date code.

4.6.1.2 Group A inspection. Add the following: "The following changes shall be made to Table XIX:

a. Internal visual inspection and cleaning and small particle inspection in accordance with ¶4.7.1.1 are required prior to seal.

b. Electrical characteristics shall be recorded twice: once (excluding DWV test) in the sequence shown, and once (including DWV test) prior to the vibration scan test. Following the second set of measurements, _ calculations

shall be made, with limits set in accordance with Table V a herein.

c. Shock test in accordance with ¶4.7.16 shall be performed just after vibration scan and prior to PIND.

d. P.I.N.D. test shall be performed after shock test and prior to operational reliability test.

e. Dielectric withstanding voltage test shall be deleted from the final measurements of electrical characteristics."

4.6.1.2.1 Sampling plan. Modify as follows: "The test sequence shall be as follows:

a. Internal visual and cleaning and small particle inspections (pre-seal)
b. Table XIX electrical characteristics including DWV (read and record)
c. Vibration scan
d. Shock
e. PIND
f. Operational reliability
g. Table XIX electrical characteristics excluding DWV (read and record and calculate deltas)
h. Examination of product"

Add Table XIX a. as follows:

TABLE XIX a. Delta Limits for Group A Inspection

Parameter	$\overline{\text{Limit}}$
Contact voltage drop or resistance	± 20% -or- ± 5σ, ± 3σ*
Pickup voltage	± 10%
DC coil resistance	± 5%
Contact bounce, operating and release times	± 10%

*Note: The detail specification or procurement document will specify whether the percentage Δ criterion or that based on standard deviation shall be used. The procedure for use of the statistical method is as follows: At the completion of operational reliability test, the distribution of measurements at each measurement point shall be plotted and standard deviation calculated. Relays having contact sets with measurements in excess of 5σ shall be removed from the lot and rejected. The standard deviation calculation shall be repeated with the measurements of the balance of the lot and relays having contact sets with measurements in excess of 3σ shall be rejected.

4.6.2 Periodic inspection. Delete and substitute as follows:

4.6.2 Sample inspections. If specified in the detail specification or procurement document, group B inspection shall be performed on a sample of at least 10 screened devices from each inspection lot. Otherwise, group B and C inspections apply only to manufacturers of qualified relays.

4.6.2.1 Group B inspection. Modify Table XX as follows: The following tests are not required: motor load dc, motor load ac, resistive load ac, inductive load ac, lamp load, vibration scan, and dielectric withstanding voltage.

4.6.2.1.1 Sampling plan. For manufacturers of non-qualified relays, delete and substitute as follows: "Group B samples shall be selected at random from each lot of relays which have passed the group A inspections. Sample size and allowable failures shall be as follows: low temperature operation 1(0), thermal shock 1(0), each endurance test 2(0), solderability and resistance to soldering heat 2(0) (using samples previously subjected to other group B tests).

4.6.2.1.2 Failure criteria. Add the following: "If group B is required and one or more relays fail the group B inspection, the manufacturer shall notify the JPL contract technical manager and contract negotiator within two working days."

4.6.2.1.3 Disposition of sample units. Add the following: "If lot qualification test is required, samples used in group B shall be retained by the manufacturer with the master file of data for the lot."

4.6.2.2 Group C inspection. Applies only to manufacturers of qualified relays.

Add ¶4.6.4 as follows:

4.6.4 Pre-seal inspection. Pre-seal visual and mechanical inspection, and cleaning and small particle inspection shall be performed in accordance with ¶4.7.1.1.

4.7 Methods of examination of product.

4.7.1 Examination of product.

Add ¶4.7.1.1 as follows:

4.7.1.1 Pre-seal inspection. Prior to sealing the relay enclosure, a visual inspection to verify compliance with requirements herein and in the detail specification and a cleaning and small particle inspection following the guidelines of MIL-R-39016 Appendix A shall be performed. (Cannular flushing may be required by the detail specification.)

4.7.7 Contact voltage drop.

4.7.7.1 Contact resistance. Add the following: "For relays rated ≤2A, this measurement shall be sequenced such that the contacts will make "dry",

the current will be applied and the measurement recorded, the current will be removed, and the contacts will break "dry" (so as not to impair the dry circuit capability of the relay)."

4.7.12 Thermal shock (see 3.18). Modify as follows: "The provisions of ¶4.7.12.1 also apply."

Add ¶4.7.12.1 as follows:

4.7.12.1 Thermal shock for group B. Relays shall be tested in accordance with MIL-STD-202 Method 107, test condition B-3 (100 cycles).

4.7.30 Operational reliability. Modify as follows: Each relay shall be subjected to a total of 6000 cycles, 3000 at the maximum rated temperature and 3000 at the minimum rated temperature. The minimum open-circuit voltage shall be 3 V dc. If specified in the detail specification or procurement document, the making and breaking of the rated resistive current shall be done by a series contact of a test relay or switch. After each 1,000 cycles, contact resistance or voltage drop shall be recorded at room temperature for, and traceable to, each set of contacts, and the Δ shall be calculated. The Δ calculation shall compare the most recent set of measurements with the initial measurements.

4.7.30.1 Temperature cycling. Modify as follows: "The effective total transfer time between temperatures shall not exceed 2 minutes. During each high and low temperature step a run-in test of 50 operations "set" and 50 operations "reset", using $\leq$0.1A and $\leq$6.0V, shall be performed. Failure of a contact to operate correctly shall be cause for rejection. Upon conclusion of the test the relays shall be stabilized at room ambient temperature and a visual inspection performed. There shall be no evidence of cracking, peeling, or flaking of the relay finish."

4.7.30.2 High temperature operation. Delete the final sentence and substitute as follows: "While still at this temperature, the relays shall be subjected to 3,000 cycles of operation as specified in 4.7.30. After each 1,000 cycles, the relays shall be stabilized at room temperature and contact resistance or voltage drop shall be measured (and Δ calculations made) in accordance with ¶ 4.7.30. The contact measurement current shall be as near the current rating as practicable but not less than 40% of the rated current."

4.7.30.3 Low temperature operation. Delete the final sentence and substitute as follows: "While at this temperature, the relays shall be subjected to 3,000 cycles of operation as specified in 4.7.30. After each 1,000 cycles, the relays shall be stabilized at room temperature and contact resistance or voltage drop shall be measured (and Δ calculations made) in accordance with ¶ 4.7.30. The contact measurement current shall be as near the current rating as practicable but not less than 40% of the rated current."

5. PACKAGING

5.3 Marking. Add the requirement for marking the initial container (unit package) with the JPL trace number.

5.4 General.

5.4.1 Exterior containers. Add the following: "The external shipping container shall be marked 'FLIGHT ELECTRONIC PARTS'."

Add paragraph 5.4.4 as follows:

5.4.4 Packing slip and invoice. The packing slip and invoice shall include the JPL trace number associated with each line item.

6. NOTES

6.1 Intended use. Add the following: "Relays conforming to this specification are intended for use when class S qualified parts are not available. When a relay is qualified for class S QPL listing, this specification shall not be used for new design."

6.2 Ordering data. Delete and substitute as follows: "Acquisition documents will specify the following:

a. Part number
b. Associated detail specification number
c. Any difference in test data requirements from those listed in 3.30 herein
d. Name and telephone number of JPL contract negotiator
e. Name and telephone number of JPL contract technical manager
f. Name and telephone number of JPL QA coordinator of source inspections
g. JPL trace number
h. Any other special requirements which differ from those indicated herein or in the detail specification (e.g., those involving source inspections, traceability, testing, etc.)."

6.4 Definitions. Add the following definitions:

6.4.63 Contract technical manager. The contract technical manager shall be the principal technical interface between the manufacturer and JPL.

6.4.64 Contract negotiator. The contract negotiator shall be the cognizant JPL procurement representative.

6.4.65 Control unit. A control unit is a part of the same device type as the relays being tested, but which is not subjected to any of the stresses that are applied to the test specimens. It is used to verify the repeatability and accuracy of measurements.

6.4.66 Trace number. The trace number is the number assigned by the procurement document to link a part number to a specific purchase order or Order Release.

6.4.67 Delta (_) calculation. The delta (_) calculation is the comparison of the measurement after stress has been applied with that recorded prior to application of that stress.

6.4.68 Screening. Screening consists of the group A inspections performed on 100% of the parts.

6.4.69 Quality conformance inspection (QCI). QCI consists of the group B inspections required for each lot.

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